भारतीय मानक
Indian Standard

IS 16476 (Part 1) : 2017
(Reaffirmed 2022)

एल ई डी आधारित सौर लालटेन

भाग 1 विशिष्टि

LED Based Solar Lantern

Part 1 Specification

ICS 27.160

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March 2017 **Price Group 3**

Solar Photovoltaic Energy Systems Sectional Committee, ETD 28

FOREWORD

This Indian Standard (Part 1) was adopted by the Bureau of Indian Standards, after the draft finalized by the Solar Photovoltaic Energy Systems Sectional Committee had been approved by the Electrotechnical Division Council.

This standard covers requirements for portable LED based solar lanterns, which are lighting systems consisting of white LEDs as a light source, a storage battery (Sealed maintenance free lead-acid or nickel-metal hydride (NiMH) or lithium based battery or other) and electronics, all placed in a suitable housing made of durable material such as metal or plastic and a separate PV module. The battery is charged by electricity generated through the PV module through a charge controller. For the purpose of this standard, the service environment of the lantern (without the PV module) can be described as being fully covered by a enclosure to protect it from direct rain, sun, wind-blown dust, fungus, etc.

This standard has been dealt within two parts, one exclusively on the specification and the other on methods of test. The other part in this series is:

IS 16476 (Part 2)	LED Based Solar Lantern: Part 2 Method of Tests

Considerable assistance has been derived from IEC/TS 62257-9-5 (2013) in the formulation of this standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard
LED BASED SOLAR LANTERN
PART 1 SPECIFICATION

1 SCOPE

This standard (Part 1) covers requirements for portable LED based solar lanterns, which are lighting systems consisting of white LEDs as a light source, a storage battery [Sealed maintenance free lead-acid or nickel-metal hydride (NiMH) or lithium based battery or other] and electronics, all placed in a suitable housing made of durable material such as metal or plastic and a separate PV module. The battery is charged by electricity generated through the PV module through a charge controller. For the purpose of this standard, the service environment of the lantern (without the PV module) can be described as being fully covered by a enclosure to protect it from direct rain, sun, wind-blown dust, fungus, etc.

2 REFERENCES

The following standards are necessary adjuncts to this standard:

IS No.	*Title*
694 : 2010	Polyvinyl chloride insulated sheathed and unsheathed cables with rigid and flexible conductor for rated voltages upto and including 450/750 V (*fourth revision*)
14286 : 2010	Crystalline silicon terrestrial photovoltaic (PV) modules — Design qualification and type approval
16102	Self-ballasted LED lamps for general lighting services:
(Part 1) : 2012	Safety requirements
(Part 2) : 2012	Performance requirements
IS/IEC 60529	Classification of degrees of protection provided by enclosures (IP Code)
16476 (Part 2) : 2015	LED based solar lantern: Part 2 Methods of test

3 TERMINOLOGY

For the purpose this standard the following definitions shall apply.

3.1 LED Based Solar Lantern — Solar photovoltaic (PV) based lanterns, which are lighting systems consisting of white LEDs as a light source, a storage battery (Sealed maintenance free lead-acid or nickel-metal hydride (NiMH) or lithium based battery or other) and electronics, all placed in a suitable housing made of durable material such as metal or plastic and a separate PV module. The battery is charged by electricity generated through the PV module through a charge controller.

3.2 Duty Cycle — The hours of operation per day of the solar lantern when charged under average daily insolation of 5.5 kWh/m^2 on a horizontal surface.

3.3 Illuminance of an Elementary Surface Symbol E — The luminous flux received by an elementary surface divided by the area of this surface.

NOTE — In the SI system of units illuminance is expressed in lux (lx) or lumens per square metre (lm/m^2).

3.4 Capacity of a Cell or a Battery — The quantity of electricity (electric charge), usually expressed in ampere-hour (Ah), which a fully charged battery can deliver under specified conditions

3.5 Lux (SI Unit of Illuminance) — Illuminance produced on a surface of area 1 m^2 by a luminous flux of 1 lumen uniformly distributed over that surface.

3.6 Symbol A — SI unit of electric current, equal to the direct current which, if maintained constant in two straight parallel conductors of infinite length, of circular cross-section with negligible area, and placed 1 m apart in vacuum, would produce between these conductors a force per length equal to 2×10^{-7} N/m.

NOTE — CGPM definition is as follows: 'The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 metre apart in vacuum, would produce between these conductors a force equal to 2×10^{-7} newton per metre of length'.

3.7 IP Class — IP Rating — Ingress Protection — Degree of protection provided by enclosures for electrical equipment against penetration by foreign bodies and dust/water.

3.8 Portable — Products or sub-systems are portable when two or more of the main components (energy source, energy storage, and light source) are connected in a way that makes the product or sub-system easy for an individual to carry.

3.9 Light Emitting Diode — LED solid state device embodying a p-n junction, emitting optical radiation when excited by an electric current.

4 SAMPLING

4.1 Selection of Samples

Eight numbers of solar lantern complete in all respect shall be taken at random from a production batch in accordance with the procedure given in IS 10673. The lanterns must have been manufactured from components conforming to the requirements of this standard . The charge controller and the current driver have been manufactured by using the standard components in accordance with the relevant circuit diagrams. The manufacturer has to certify that the lanterns have been subjected to the manufacturer's normal inspection, quality control during production and acceptance procedure. The lanterns shall be complete in every detail and LEDs used shall be UV free and the copy of the LED spectrograph has to be provided along with the samples. The bill of materials, drawings of PCB layout, component layout and circuit diagram shall also be provided by the manufacturer along with the samples.

5 VISUAL SCREENING

For type tests, the lantern shall pass the requirements as defined in **4** of IS 16476 (Part 2). For routine tests, the lantern shall be subjected to requirements as defined in **4.2.1** of IS 16476 (Part 2).

6 LIGHTING CHARACTERISTICS

6.1 Minimum Illuminance With Distance

The lantern shall deliver minimum illuminance (lux) as per Table 1, when tested as per **8.3.2.1** of IS 16476 (Part 2).

Table 1 Minimum Illuminance with Distance

(*Clause* 6.1)

Sl No.	Distance from the Center of the Base of the Lantern m	Minimum Illuminance when Detector is Horizontal on the Same Plane as the Base of the Lantern lux	Minimum Illuminance when Detector is Vertical on the Same Plane as the Base of the Lantern lux
(1)	(2)	(3)	(4)
i)	0.3	50	160
ii)	0.6	10	50
iii)	0.9	4.5	25
iv)	1.2	3.0	15
v)	1.5	2.0	10

The illuminance should be uniform when measured in all angle at distance as given above on the plane of the base of the lantern.

6.2 LED

The LEDs used in the lantern should be UV radiation free and the colour temperature should be in the range of 5 500 - 6 600° K and the LEDs shall conform to IS 16102 (Part 1) for safety requirements and IS 16102 (Part 2) for performance requirements.

6.3 Lumen Maintenance Test

The luminous flux of the lantern after 2 000 h when tested as per lumen maintenance test given in **15** of IS 16476 (Part 2) shall not fall below 70 percent of its original value.

7 USABILITY CHARACTERISTICS

7.1 Autonomy

The solar lantern shall operate for a minimum of 12 h from fully charged condition to permissible discharge condition, when tested as per **8.3.2.3** (Autonomy) of IS 16476 (Part 2).

7.2 Duty Cycle

Duty cycle is defined as the hours of operation per day when charged under average daily insolation of 5.5 kWh/m^2 on a horizontal surface.

The solar lantern shall achieve an average duty cycle of 4 h a day under average daily insolation of 5.5 kWh/m^2 on a horizontal surface when tested as per **11** of IS 16476 (Part 2).

7.3 Circuit Efficiency

7.3.1 *Charging Circuit Efficiency*

The generator to battery charging efficiency of the lantern at nominal battery voltage should be minimum of 90 percent when testing as per **10** of IS 16476 (Part 2). This requirement is applicable on lanterns with inbuilt charge controller only.

7.3.2 *LED Driver Efficiency and Variation in Output*

The LED driver efficiency should be more than 85 percent and the variation in the LED driver output should not be more than 3 percent in the entire permissible voltage range of the battery when tested as per **8.3.2.2** of IS 16476 (Part 2).

8 DURABILITY

8.1 Drop Test

The lantern shall pass the drop test as defined in **14.3.1** of IS 16476 (Part 2).

8.2 Switch and Connector Test

The lantern shall pass the switch and connector test as defined in **14.3.2** of IS 16476 (Part 2).

8.3 Protection Against Open Circuit, Short Circuit and Reverse Polarity

8.3.1 *No Load Protection*

The solar lantern must withstand the open circuit condition when tested as per **13.1.1** of IS 16476 (Part 2).

8.3.2 *Load Short Circuit Protection*

The solar lantern must withstand the short circuit condition when tested as in **13.1.2** of IS 16476 (Part 2).

8.3.3 *Battery Reverse Polarity Protection*

The solar lantern must withstand the reverse polarity condition when tested as per **13.1.3** of IS 16476 (Part 2).

8.4 Charge Controller Behaviour, Temperature Compensation and Stand by Self Consumption

8.4.1 *Overcharge and Deep Discharge Protection*

The charge controller shall have all the protection against battery overcharge and deep discharge. The tests shall be carried out as per **9** of IS 16476 (Part 2).

8.4.2 *Temperature Compensation*

The lantern shall pass the temperature compensation test when subjected to the temperature compensation test as per **12** of IS 16476 (Part 2).

8.4.3 *Standby Self-Consumption*

The self consumption of the lantern when measured as per **9.3.5** of IS 16476 (Part 2) shall not be more than 5 percent.

8.5 PV Module

The PV module supplied with the lantern shall be tested as per the PV module characteristic test as per **6** of IS 16476 (Part 2) and the results shall meet the specifications provided with the lantern. Also, the modules shall pass the damp heat test as per **10.13** of IS 14286.

8.6 Cables

A cable conforming to IS 694 of at least 5 m length should be provided for inter-connection between the module and the lantern.

8.7 Battery

The battery supplied with the lantern shall be tested as per **7** of the IS 16476 (Part 2) and the battery capacity and the battery storage efficiency should meet the declared values as specified by the manufacturer.

8.8 Protection Against Environmental Aspects

The lantern should have an IP rating of 43 or above as per IS/IEC 60529 and lantern should conform to **4.2.1.3** (d) and (e) of IS 16476 (Part 2) after the test.

9 MARKING

9.1 The manufacturer shall provide the solar lantern and the PV module with the following clear and indelible markings:

a) Name, monogram or symbol of the manufacturer/supplier;
b) Type or model number;
c) Nominal module and battery voltage;
d) Serial or batch number;
e) Polarity of terminals or leads; and
f) Precautionary warning concerning special requirements for storage, putting into service and handling.

Labelling on equipment shall be in accordance with good ergonomic principles so that warning notices, controls, indications, testing facilities, fuses, etc, are sensibly placed and logically grouped to facilitate correct and unambiguous identification.

9.2 Durability and Legibility of Marking

a) Compliance is checked by inspection and by trying to remove the marking by rubbing lightly, for 15s each time, with two pieces of cloth, one soaked with water and the other with petroleum spirit.
b) The marking shall be legible after the test.

NOTE — The petroleum spirit used should consist of a solvent hexane with a content of aromatics of maximum 0.1 percent volume percentage, a kauri-butanol value of 29, an initial boiling-point of approximately 65°C, a dry-point of approximately 69°C and a density of approximately 0.68 g/cm³.

9.3 BIS Certification Marking

The solar lanterns may also be marked with the Standard Mark.

9.3.1 The use of Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

10 TESTS

10.1 Type Tests

The following shall constitute the type tests:

a) Visual screening (*see* **5**),
b) Minimum illuminance with distance (*see* **6.1**),
c) Lumen maintenance test (*see* **6.3**),

d) Autonomy (*see* **7.1**),
e) Duty cycle (*see* **7.2**),
f) Circuit efficiency:
    1) Charging circuit efficiency (*see* **7.3.1**), and
    2) LED Driver efficiency and variation in output (*see* **7.3.2**),
g) Drop test (*see* **8.1**),
j) Switch and connector test (*see* **8.2**),
k) No Load protection (*see* **8.3.1**),
m) Load short circuit protection (*see* **8.3.2**),
n) Battery reverse polarity protection (*see* **8.3.3**),
p) Overcharge and deep discharge protection (*see* **8.4.1**),
q) Temperature Compensation (*see* **8.4.2**),
r) Standby self-consumption (*see* **8.4.3**),
s) PV module test (*see* **8.5**),
t) Battery test (*see* **8.7**),
u) Protection against environmental aspects (*see* **8.8**),
v) Marking (*see* **9**).

The sequence of the type tests shall be given as in Fig. 1. In case, the failure is in more than one batch or both samples in any of the batches, it shall be considered as a failure of type test. However, in case of failure of one sample in any one of the batches, test shall be repeated on the two spare samples and shall be considered pass only, if both the spare samples pass the complete testing for that particular batch.

10.2 Acceptance Tests

The following shall constitute the acceptance tests:

a) Visual screening (*see* **5**),
b) Minimum illuminance with distance (*see* **6.1**),
c) LED (*see* **6.2**),
d) Autonomy (*see* **7.1**),
e) Duty cycle (*see* **7.2**),
f) Circuit efficiency:
    1) Charging circuit efficiency (*see* **7.3.1**),
    2) LED driver efficiency and variation in output (*see* **7.3.2**),
g) Drop test (*see* **8.1**),
j) Switch and connector test (*see* **8.2**),
k) No load protection (*see* **8.3.1**),
l) Load Short circuit protection (*see* **8.3.2**),
m) Battery reverse polarity protection (*see* **8.3.3**),
n) Overcharge and deep discharge protection (*see* **8.4.1**),
p) Temperature compensation(*see* **8.4.2**),
q) Standby self-consumption (*see* **8.4.3**),
r) PV module test (*see* **8.5**),
s) Battery test (*see* **8.7**),
t) Protection against environmental aspects (*see* **8.8**), and
u) Marking (*see* **9**).

Sampling plan shall be as agreed to between the manufacturer and the purchaser.

10.3 Routine Tests

The following shall constitute the routine tests:

a) Visual screening (*see* **5**), and
b) Marking (*see* **9.1**).

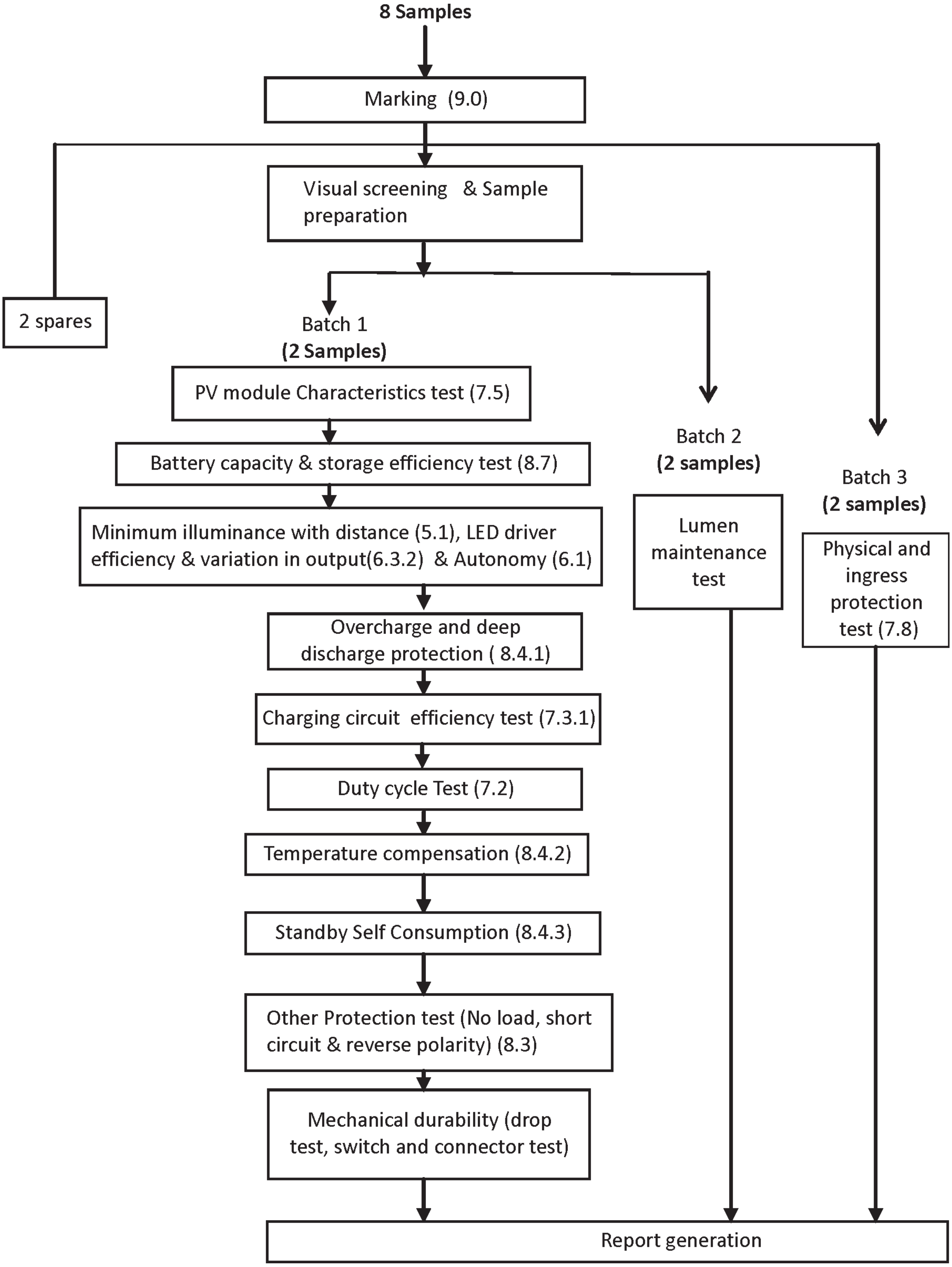
8 Samples
Marking (9.0)
Visual screening & Sample preparation
2 spares
Batch 1
(2 Samples)
PV module Characteristics test (7.5)
Battery capacity & storage efficiency test (8.7)
Minimum illuminance with distance (5.1), LED driver efficiency & variation in output(6.3.2) & Autonomy (6.1)
Overcharge and deep discharge protection (8.4.1)
Charging circuit efficiency test (7.3.1)
Duty cycle Test (7.2)
Temperature compensation (8.4.2)
Standby Self Consumption (8.4.3)
Other Protection test (No load, short circuit & reverse polarity) (8.3)
Mechanical durability (drop test, switch and connector test)
Batch 2
(2 samples)
Lumen maintenance test
Batch 3
(2 samples)
Physical and ingress protection test (7.8)
Report generation

FIG. 1 TYPE TEST SEQUENCE

Bureau of Indian Standards

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Amendments Issued Since Publication

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AMENDMENT NO. 1 DECEMBER 2019

TO

IS 16476 (PART 1) : 2017 LED BASED SOLAR LANTERN PART 1 SPECIFICATION

(*Page* 2, *clause* **6.2**) — Substitute the following for the existing clause:

‘6.2 LED

The white LEDs used in the lantern should be UV radiation free and the colour temperature should be in the range of 5 500 - 6 500 K.’

(ETD 28)

Publication Unit, BIS, New Delhi, India